Mixed Interaction Spaces – a new interaction technique for mobile devices

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ABSTRACT
In this paper, we describe a new interaction technique for mobile devices named Mixed Interaction Space that uses the camera of the mobile device to track the position, size and rotation of a fixed-point. In this demonstration we will present a system that uses a hand-drawn circle, colored object or a person's face as a fixed-point to determine the location of the device. We use these features as a 4 dimensional input vector to a set of different applications.

Categories and Subject Descriptors
H.5.2 [**User Interfaces**] – *Input devices and strategies.*

General Terms
Algorithms, Design, Human Factors.

Keywords
Mixed Interaction Spaces, Mobile Interaction, Computer Vision, Mobile Phones, Interaction Techniques, Face Tracking

1. INTRODUCTION
The majority of interaction with mobile devices falls into two categories: It is either done by using a keypad or by using a stylus. Each of these input techniques has its limitation and interaction with mobile devices can be cumbersome. The keypad is good at dialing numbers, can be used to write small text messages, but is generally not good at supporting games or pointing and dragging applications. The pen is good for pointing but requires the use of two hands. As mobile devices move from being mainly a phone or a notebook to becoming a multifunctional device there is a need for developing new interaction techniques for mobile devices. Speech interaction is coming to mobile devices, but is still limited to recognizing a small set of predefined commands. Accelerometer based interaction is another promising new interaction form, but instead of using movement we wanted to explore how the space the mobile device inhabit can be used as interaction space.

For some time we have developed an interaction concept for mobile devices called Mixed Interaction Space (MIXIS) [2][3]. Where several of the other input techniques focus on interaction on the device, MIXIS uses the space surrounding the mobile device for its input. We track the location of the mobile device by using its built-in camera to detect a fixed-point in its surroundings

and use this fixed-point to determine the position and rotation of the device in the 3D space. The position of the mobile phone in the space is thereby transformed into a 4 dimensional input vector. One of the advantages of MIXIS is that it uses the camera that most mobile devices are equipped with instead of additional or specialized external hardware.

Several other projects have worked with input for mobile devices [4][5][7], but all of them have used two dimensional barcodes as their fixed-point and none of them have explored the possibilities of the interaction space spanned by the camera's field of vision.

2. MIXED INTERACTION SPACE
By using the camera to track a fixed-point, a mixed reality interface is created. The interface is a combination of the physical space the device is moved in and the digital space where the movement is mapped to interactions in different applications. The mixed interaction space has the shape of an inverse pyramid. When the device is close to the fixed-point the space is small, and the further away from the fixed-point the device is moved the larger the space becomes. Moving the phone in the interaction space can be mapped to actions in the graphical user interface on the device or an action on a nearby device or display. Figure 1 shows the concepts.
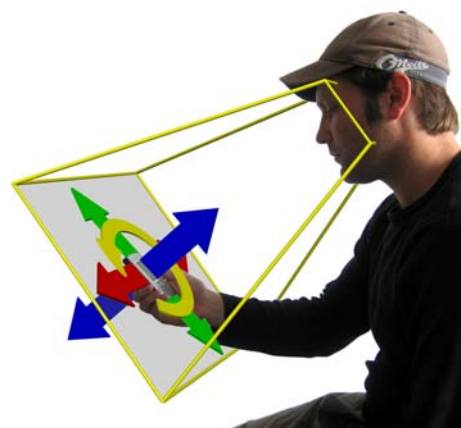

Figure 1: The Mixed Interaction Space with face tracking

We have worked with a set of different fixed-points. In the first version we use a hand-drawn circle as a fixed-point. In a later version we use a coloured object and in the newest version, we use a person's face as the fixed point and track it with a mobile device that has a camera facing towards the user e.g. the Nokia 6680.

3. TRACKING

We have used two different algorithms for performing the actual tracking of the device. In the first version we use the Randomized Hough Circle detection algorithm [6], optimized to run on mobile devices, to find the location of the device. The algorithm is pretty robust and works with different lightning conditions, and the circle do not need to be perfect, a hand drawn circle works as well as a printed.

The second algorithm we use is an optimized version of the CamShift algorithm developed at Intel [1]. This algorithm uses a color histogram to guide a mean shift algorithm and is able to track an object with a distinct color signature or the users face if the front camera on the mobile device in use.

Especially the face tracking algorithm provides new possibilities since it does not require any external fixed-point. The fixed-point is always with the user, since being a part of the user, and is therefore highly suitable as interaction technique for mobile use.

4. APPLICATIONS

We have built a number of applications based on Mixed Interaction Space.

ImageZoomViewer, DrawME and Layered Pie Menu are examples of applications that run on the phone. ImageZoomViewer is an application for panning and zooming large pictures by moving the device in the 3D space (figure 2). DrawME recognized a hand drawn symbol inside a circle and this icon can be used as a short cut for calling e.g. a phone number (only with the circle algorithm) and Layered pie menu present a pie menu in which the user browse through the different layers of the menu by moving the device closer or further away. An item can be selected by moving the device away from the center.

Figure 2: Shows ImageZoomViewer running with a subway map. Facetracking is used to pan and zoom on the picture.

BlueMix and BlueServer are two generic components for developing MIXIS applications to control interaction on remote computers with the mobile devices. BlueMix is a program for the mobile phone that connects to a nearby PC and streams the input data from the MIXIS algorithm to the computer. BlueServer is a PC application that communicates with one or more BlueMix application over Bluetooth. Other clients e.g. developed in Flash or C# can connect to a socket port and thereby communicate with the BlueServer. Some of the application we have developed with this setup are Drozo where a user can drag, zoom and rotate images on a large wall display, multi-user Pong where two users can play pong on a large screen controlled by MIXIS and a multi-user cursor system where up to seven users can control a cursor with their mobile devices.

5. CONCLUSION

Based on the work with MIXIS we have showed that MIXIS is a novel concept for interacting with mobile devices that takes advantage of the mobile device being part of a physical world instead of being a fixed computer tied to a desktop. The goal of Mixis is not to replace the keypad or pen, but to provide an additional 4D input method that can be used in a wide set of applications where e.g. physical movement provides a better mapping than pressing a key or pointing at an icon.

We are currently working on developing several new applications and tracking algorithms based on the concept and we also focus on making the system more generic so it is easier to plug it into new applications.

6. REFERENCES

[1] Bradski, G.R., Computer Vision Face Tracking For Use in a Perceptual User Interface, Intel Technology Journal Q2, 1998.

[2] Hansen, Thomas Riisgaard, Eriksson, Eva., Lykke-Olesen, Andreas, Mixed Interaction Space – Expanding the Interaction Space with Mobile Devices, To appear at British HCI 2005, 2005.

[3] Hansen, T. R., Eriksson, E. & Lykke-Olesen, A., Mixed Interaction Space — Designing for Camera Based Interaction with Mobile Devices, in CHI'05 Extended Abstracts of the Conference on Human Factors in Computing Systems, ACM Press, pp.1933–6, 2005.

[4] Rohs, M., Real-world Interaction with Camera Phones, in H. Tokuda & H. Murakami (eds.), Proceedings of the 2nd International Symposium on Ubiquitous Computing Systems (UCS 2004), 2004.

[5] SemaCode Corporation [2005], Sem@Code, http://semacode.org/.

[6] Xu, L., Oja, E. & Kultanen, P., A New Curve Detection Method: Randomized Hough Transform (RHT), Pattern Recognition Letters 11(5), 331–8, 1990.

[7] Yee, K.-P., Peephole Displays: Pen Interaction on Spatially Aware Handheld Computers, in V. Bellotti, T. Erickson, G. Cockton & P. Korhonen (eds.), Proceedings of SIGCHI Conference on Human Factors in Computing Systems (CHI'03), CHI Letters 5(1), 2003.